



BE IT KNOWN that I, ***John K. JUNKERS***, have invented  
certain new and useful improvements in

***WASHER AND FASTENER PROVIDED WITH A WASHER***

of which the following is a complete specification:

CROSS-REFERENCE TO A RELATED APPLICATION

This application is a continuation-in-part of patent application serial no. 10/427,103 which is a division of patent application serial no. 10/010,377; now patent number 6,609,868; it is also a continuation-in-part of patent application serial no. 10/120,343; and it is also a continuation-in-part of patent application serial no. 10/112,101.

BACKGROUND OF THE INVENTION

The present invention relates to a washer and a fastener provided with a washer.

It is known to fasten objects with one another with power tools which use fasteners having a multi-part replacement nut, for example including an inner sleeve, an outer sleeve, and a washer. Such a replacement nut is disclosed for example in our patent no. 5,341,560. Another replacement nut is disclosed in our patent no. 6,254,323 in which a bolt has a spline underneath its upper thread, to which a washer is non-rotatably connected, and the bolt also has engaging means for applying a reaction force, while an active force of the same tool turns the nut on the bolt

thread and the washer face. In the fastener disclosed in both above mentioned patents, the common features are the use of the action and reaction force of one tool, the elimination of reaction arms on power tools, the conversion of torque to torsion-free bolt stretching and obtaining for the first time the desired residual bolt load rather than a torque, which is estimated based on calculated frictions rather than on actual frictions or a tension, which is based on estimated bolt relaxation when the force is transmitted from the elongated bolt to the hand-tight nut.

When in this application the "bolt" is used, it is used in a very broad term to cover any fastening element which is provided with a thread, such a bolt, a stud, a screw, a threaded rod, a stretch bolt, a through-bolt, a blind casing bolt, etc.

Some solutions are disclosed in U.S. patent applications serial nos. 10/112,101, 10/120,343, 10/427,103, and U.S. patent 6,609,868.

### SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a washer and also a fastener with the washer, which provides further solutions to the above specified problems.

In keeping with these objects and with others which will become apparent hereinafter, one feature of the present invention resides, briefly stated, in a washer, comprising a body having an axis and provided with a first face surface located at one axial side and adapted to cooperate with a nut, a second face surface located at an opposite axial side and adapted to cooperate with an object to be assembled or disassembled, and at least one additional turning resistant surface adapted to cooperate with a bolt, said additional turning resistant surface of said body being formed as a frictional surface providing a friction between said body and the bolt to frictionally impede the bolt from turning and at the same to allow the bolt to be displaced in an axial direction when the nut is turned, said second face surface of said body being formed to provide a friction between said body and the object and therefore to impede said body from turning, and said first face surface of said body being formed with a smaller frictional characteristic

that said second face surface of said body to at least reduce dragging of said body into turning by the turning nut.

In accordance with another feature of the present invention, a fastener is provided, comprising a bolt; a nut; and a washer placed on said bolt between said nut and an object to be assembled or disassembled, said bolt including a body having an axis and provided with a first face surface located at one axial side and adapted to cooperate with a nut, a second face surface located at an opposite axial side and adapted to cooperate with an object to be assembled or disassembled, and at least one additional turning resistant surface adapted to cooperate with a bolt, said additional turning resistant surface of said body being formed as a frictional surface providing a friction between said body and the bolt to frictionally impede the bolt from turning and at the same to allow the bolt to be displaced in an axial direction when the nut is turned, said second face surface of said body being formed to provide a friction between said body and the object and therefore to impede said body from turning, and said first face surface of said body being formed with a smaller frictional characteristic than said second face surface of said body to at least reduce dragging of said body into turning by the turning nut.

When the washer and the fastener are designed in accordance with the present invention, then the bolt which conventionally has a tendency to turn together with the nut is impeded from turning by the friction provided by at least one additional turning resistant surface of the body of the washer which cooperates with the bolt, and the body of the washer is impeded from turning by the friction provided by the second face surface of the washer which cooperates with the object, and simultaneously the nut during its turning experiences the lowest possible frictional resistance from the first face surface of the body of the washer and therefore does not engage the body of the washer into its turning process, so that the friction between the second face surface of the washer and the object even more reliably stops the washer from turning, and the friction between the turning resistant surface of the body of the washer and the object even more reliably holds the bolt from turning together with the nut.

The novel features which are considered as characteristic for the present invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a view showing a washer in accordance with the present invention;

Figures 2 is a view showing a fastener with a washer and a tool applied to the fastener, and a fastening method in accordance with the present invention;

Figure 3 is a view showing a further embodiment of the washer in accordance with the present invention;

Figure 4 shows still a further embodiment of the washer in accordance with the present invention;

Figures 5 shows an additional embodiment of the washer in accordance with the present invention; and

Figures 6 shows still a further embodiment of the washer in accordance with the present invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a washer in accordance with the present invention, which is identified with reference numeral 1 as a whole. The washer 1 has a body which is identified with reference numeral 2. The body 2 of the washer 1 has an axis A1, a first upper face surface 3 adapted to cooperate with a nut, a second lower face surface 4 adapted to cooperate with an object which can be formed as two parts to be assembled with one another, and at least one additional, turning resistant surface identified with reference numeral 5.

The first and second face surfaces 3 and 4 are spaced from one another in an axial direction or in other words in a direction of the axis A1. The at least one additional, turning resistant surface 5 is located radially inwardly of the body 2 of the washer 1. The surface 5 is formed so that it frictionally interacts with a bolt to impede the bolt from turning when the nut is turned and the bolt is urged to turn together with the nut. The turning resistant surface 5 can be formed so as to engage with or wedge in a thread of the bolt, for example by providing a corresponding thread 6 on the surface 5.

As can be seen from Figure 1, the body 2 of the washer 1 is composed of two parts 7 and 8 located substantially radially adjacent to one another, so that the part 7 is located radially inwardly of the part 8. The surface 5 with the thread 6 which impedes the turning of the bolt is provided radially inwardly of the part 7. The part 8 has a projection 9 which is located above the part 7 and prevents an axial upward displacement of the part 7. The projection 9 of the part 8 forms a resistive point, which in this embodiment is formed as a breaking point. In particular, the projection 9 is designed so that it can break under the action of a certain force acting in an axial upward direction.

While the surface 5 of the body 2 of the washer is formed to impede turning of the bolt during turning of the nut, the body 2 of the washer is also formed so that its turning in this process is impeded. In particular, the lower face surface 4 of the body 2 is formed as a frictional surface which has a significant friction to frictionally cooperate with the object, so that when the nut is turned and urges to turn the bolt which in turn urges to turn the washer, the body of the washer substantially does not turn or is impeded from turning because of the frictional cooperation between the second face surface 4 and the object. It is possible to take steps to increase the frictional characteristic of the lower face surface 4 of the body of the washer. In order to provide an

increased friction of the surface 4 of the body 2 of the washer, the lower face surface 4 can be additionally roughened, provided with a friction increasing coating, etc.

On the other hand, the upper face surface 3 which cooperates with the nut is formed so that it has a smaller friction than the lower face surface 4 which cooperates with the object. In particular, it can be formed so as to provide the lowest possible friction between the body 2 of the washer and the nut, so that when the nut is turned it substantially does not involve (does not drag) the body 2 of the washer into the turning process, since the washer must be held non-turnable to impede the turning of the bolt. For this purpose, the upper face surface 3 of the washer can be machined so as to have a very low roughness and high sliding properties, it can be coated with a friction-reducing coating, etc. It is also possible to produce the body of the washer so that its upper face surface 3 is machined to reduce friction while its lower face surface is not machined and is rough.

Figure 2 shows a fastener provided with the washer, and a tool applied to the fastener. The fastener has a nut 10 having an inner thread 11. The fastener further has a bolt 12 provided with an outer thread 13, and having an axis A2. The nut 10 has a lower face surface 14 which is adapted

to be placed on the upper face surface 3 of the body 2 of the washer 1. The outer thread 13 of the bolt 12 engages with the inner thread 11 of the nut 10, and also engages with the inner thread 6 of the body 2 of the washer 1.

A power tool to be used with the washer of the present invention is identified with reference numeral 15. The power tool has a housing which is identified with reference numeral 20 and a power drive which is identified with reference numeral 21. The power drive is formed for example as a cylinder-piston unit which includes a cylinder 24, and a piston 25 which is movable in the cylinder and provided with a piston rod 26. The reciprocating movement of the piston rod 26 with the piston 25 is converted into a rotary movement of a ratchet 28 through at least one drive plate 27 provided with a not shown pawl engageable with teeth of the ratchet 28. A driving element 16 is connected with the turnable ratchet 28 on the one hand and engages the nut 10 on the other hand. In order to provide such an engagement the inner surface of the driving element 16 can be provided with connecting means, for example formed as a polygonal inner surface, etc.

The power tool additionally has a non-rotatable element 17 which is connected to the immovable housing 20 to absorb a reaction created during turning of the driving element. The non-rotatable element 17

engages the body 2 of the washer 1 to prevent its rotation about the axes A1 and A2, which coincide with one another when the fastener is assembled. In order to engage the washer, the non-rotatable element 17 can be provided with connecting means formed for example as a polygonal inner surface cooperating with a polygonal peripheral surface of the body 2 of the washer 1.

The fastener with the washer is provided for fastening an object which is identified with reference numeral 18, for example to assemble parts 19 and 19' of the object 18 with one another.

When as shown in Figure 2, the power tool 15 is placed on the fastener so as to tighten or loosen the nut , the turning element 16 which is connected to the nut 10 turns the nut to overcome a thread friction with the bolt 12 and the facial friction with the washer 1 (which in accordance with the present invention can be very small) so as to turn the nut, and the non-rotatable element 17 holds the washer 1 to absorb the reaction force due to the facial friction of the washer 1 with the nut 10 (which in accordance with the present invention can be very small), its facial friction with one side of the part 19', and its turning friction with the bolt 12, so that the washer 1 does not turn but absorbs the reaction force of the power tool. Initially, when the nut

10 rotates, the bolt 12 rotates together with the nut; however, the stationary washer 1 wedges the stationary part 7 into the bolt thread 13, so that the bolt stops turning because of the interengagement of its outer thread 13 with the thread 6 of the washer 1. Therefore, the bolt 12 is stopped, and an axial force is applied to the washer 1, in particular to its part 7 in an axial upward direction when the bolt 12 is elongated by the turning nut 10. Under the action of this axial upward force, the resistive point of the washer is overcome and in particular the projection 9 of the part 8 of the washer 1 breaks off and the part 8 of the washer 1 is pulled upwardly.

Figure 3 shows another embodiment of the washer in accordance with the present invention. Here the washer which is identified with reference numeral 1' has a body 2' which is formed as a one-piece integral element with a partition 31 and a groove 32 provided to reduce a thickness of the partition and to make it breakable.

The operation of the washer 1' in accordance with the second embodiment of the present invention is substantially similar to the operation of the washer 1 of the embodiment shown in Figure 1. When the nut 10 is turned by the driving element 16 of the power tool, the bolt 12 has a tendency to turn together with the nut. As the washer 1' is held stationary

and consequently the inner part 7', the bolt becomes stationary due to the interengagement of its outer thread 13 with the inner thread 6' of the body 2' of the washer 1, but is elongated in the axial direction. An axial force which is generated during the elongation of the bolt 12 is applied axially upwardly to the radially inner part 7' of the washer 1', trying to displace the inner part 7', so that eventually it breaks the partition 31, which constitutes the resistive point, and displaces the inner part 7' of the washer 1' axially upwardly relative to the outer part 8'.

Figure 4 shows a further embodiment of the washer in accordance with the present invention. Here the washer which is identified with reference numeral 1" has a body 2". The body 2" of the washer 1" has a first upper face surface 3" adapted to cooperate with the nut, a second lower face surface 4" adapted to cooperate with an object, and the turning resistant surface identifies with reference numeral 5". The turning resistant surface 5" is located radially inwardly and is formed to engage as a wedge in a thread of the bolt, for example by providing a corresponding thread 6" on the turning resistant surface 5". The body 2" of the washer 1" is composed of two parts 7" and 8" located substantially radially adjacent to one another, so that the part 7" is located radially inwardly of the part 8".

The turning resistant surface 5" with the thread 6" is provided radially inwardly on the part 7".

The part 7" has a skirt-shaped portion 33 which is received in a correspondingly shaped lower portion 34 of an opening of the part 8". The formations 33, 34 form a resistive point of the washer. When the part 7" is pulled up after stopping the bolt from turning, the skirt-shaped portion 33 of the part 7" is slightly and permanently deformed to the size of to the straight portion of the inner opening of the part 8", to permit further upward sliding of the part 7" as the bolt elongates.

Figure 5 is a view showing a further embodiment of the present invention. The washer is identified with reference numeral 1"" and has a body 2"". The body 2"" of the washer 1"" has a first upper surface 3"" adapted to cooperate with the nut, a second lower face surface 4"" adapted to cooperate with an object, and the turning resistant surface identifies with reference numeral 5"". The turning resistant surface 5"" is located radially inwardly and is formed to engage as a wedge in a thread of the bolt, for example by providing a corresponding thread 6"" on the turning resistant surface 5"". The body 2"" of the washer 1"" is composed of two parts 7"" and 8"" located substantially radially adjacent to one another, so that the part 7""

is located radially inwardly of the part 8"". The turning resistant surface 5"" with the thread 6"" is provided radially inwardly on the part 7"".

In the embodiment shown in Figure 5 the part 7"" is provided in its lower portion with an outer knurl-portion 35 which is received in a correspondingly shaped lower portion 36 of an opening of the part 8". The knurl-shaped portion 35 of the part 7"" is press-fit in the lower portion 36 of the opening in the part 8". During the operation when the bolt is stopped and elongates, the knurl-shaped portion 35 is squashed, but still leaves enough friction to permit an upward movement of the part 7"" relative to the part 8"" without turning.

In the embodiment shown in Figure 6 the washer is identified with reference numeral 1"" and has a body identified as 2"". The body 2"" of the washer 1"" has a first upper face surface 3"" adapted to cooperate with the nut, a second lower face surface 4"" adapted to cooperate with an object, and the turning resistant surface identifies with reference numeral 5"". The turning resistant surface 5"" is located radially inwardly and is formed to engage as a wedge in a thread of the bolt, for example by providing a corresponding thread 6"" on the turning resistant surface 5"". The body 2"" of the washer 1"" is composed of two parts 7"" and 8"" located

substantially radially adjacent to one another, so that the part 7<sup>'''</sup> is located radially inwardly of the part 8<sup>'''</sup>. The turning resistant surface 5<sup>'''</sup> with the thread 6<sup>'''</sup> is provided radially inwardly on the part 7<sup>'''</sup>.

In the embodiment of Figure 6 the diameter of an outer surface 37 of the part 7<sup>'''</sup> and the diameter of an inner surface 38 of an opening in the part 8<sup>'''</sup> are selected so that the inner surface 38 of the opening of the part 8<sup>'''</sup> is press-fit on the outer surface 37 of the part 7<sup>'''</sup>. The surfaces 37 and 38 form a resistive point of the washer. The press-fit is selected so that after the bolt is stopped and an axial force is applied to the washer 1<sup>'''</sup> in an axial direction when the bolt 12 is elongated, the press fit of the surfaces 37 and 38 is overcome and the part 7<sup>'''</sup> can axially slide relative to the part 8<sup>'''</sup>.

In the embodiments shown in Figures 3-7, similarly to the embodiment shown in Figure 1, the upper face surface of the body 2 of the washer 1 has a low frictional characteristic, while the lower face surface of the body 2 of the washer 1 has a high frictional characteristic, which can be achieved by the same means as described in connection with the embodiment shown in Figure 1.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in washer, fastener provided with a washer, method of power tool for fastening with the use of the washer, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.